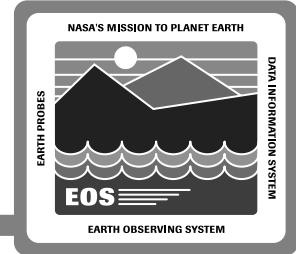


Planning and Scheduling Subsystem

Tony Cetuk

System Design Review - 28 June 1994

Planning and Scheduling Subsystem Outline



P & S Subsystem Overview

Design Drivers

Context Diagram

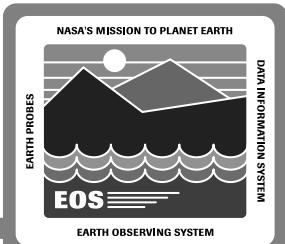
- Overview
- Data Flow Scenarios

P & S Subsystem Design

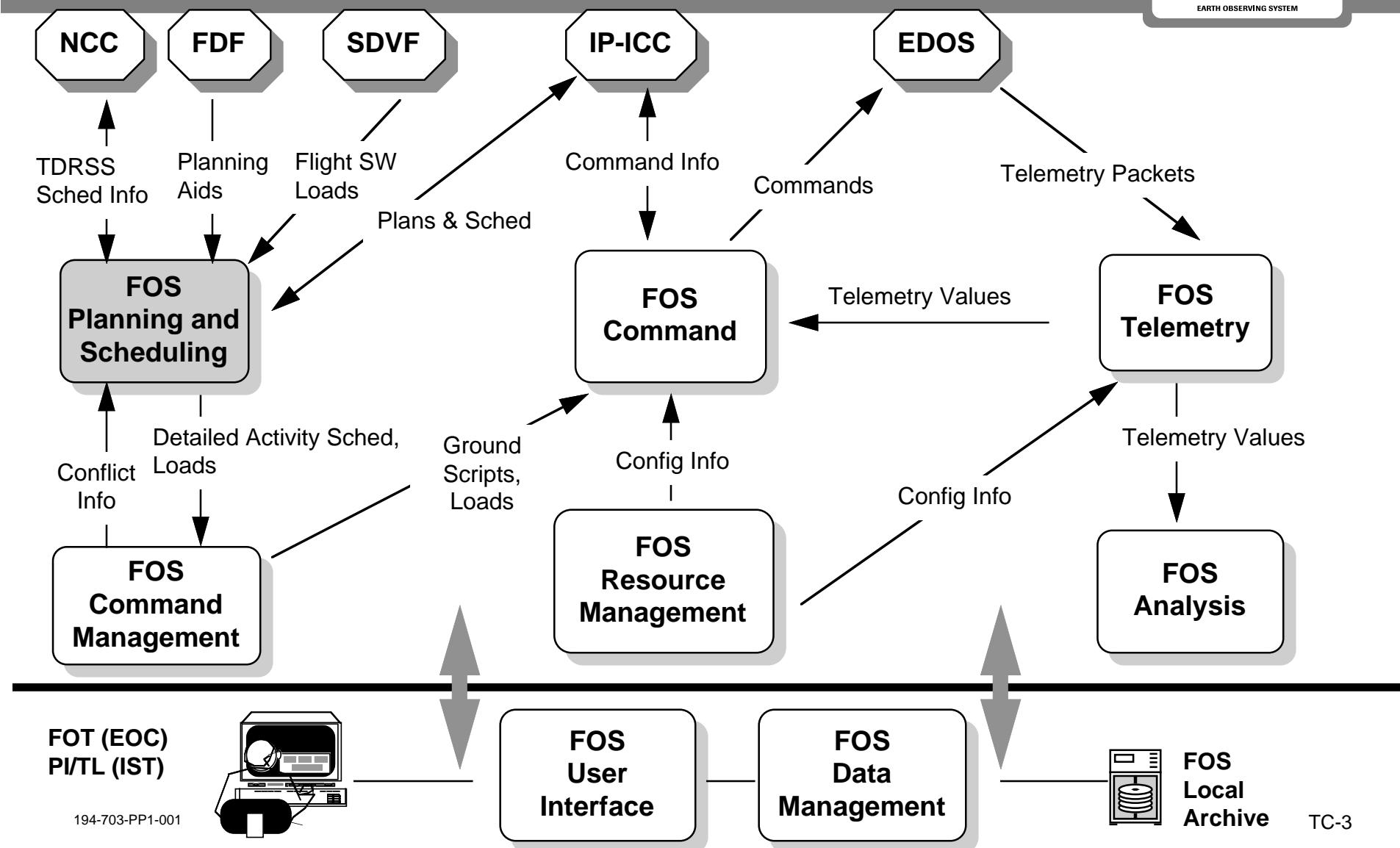
- Object Model
- Class Descriptions

Design Scenarios

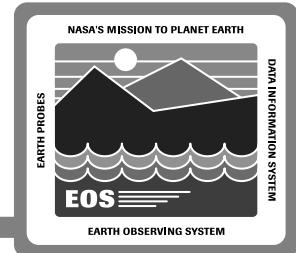
- Event Trace



FOS Subsystem Design



Planning & Scheduling Subsystem Overview

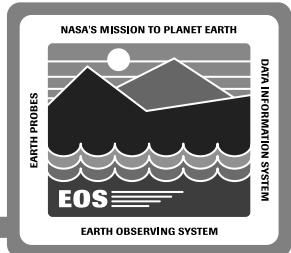


Objective:

- Produce an integrated, conflict-free schedule of activities for spacecraft, instrument and ground resources

Functions:

- Establish TDRSS contact times
- Integrate and constraint check instrument and subsystem schedules
- Incorporate TOOs and Late Changes
- Provide global visibility and conflict information throughout schedule development



Design Driver Inputs

System Requirements

- ECS Level 3 Performance and Functional Requirements
- ECS Operations Concept
- Statement Of Work

Prototype Demonstrations

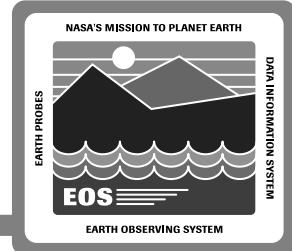
- Phase 1 Prototype Results Review (November 30, 1993)
- Ongoing demos to acquire user feedback

GSFC Distributed P & S Prototype Lessons Learned

- Coordinated study between GSFC, JPL and University of Colorado

Operations Experience

- Mission planning heritage systems (e.g. GSFC, JPL, Hughes, Loral)



Design Drivers

Distributed Architecture

- Independent and separate processes passing messages over the network to geographically distributed ISTs
- Flexibility to interface with IP ICCs for supporting instrument planning and scheduling needs (e.g. ASTER ICC)

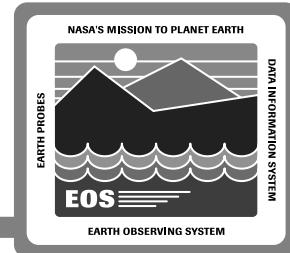
Evolvability

- Encapsulation of functionality to accommodate growth and changes to the baseline and operations concept

Global Visibility

- Provide the ISTs and IP ICCs visibility into the overall state of the mission plan to support constraint resolution
- Timeline and Map display to visualize mission plan over time and space

Design Drivers (cont.)

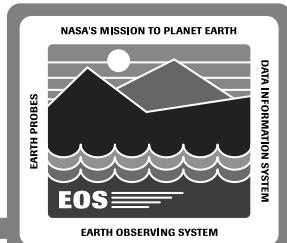


Seamless Integration with the Command Management Subsystem

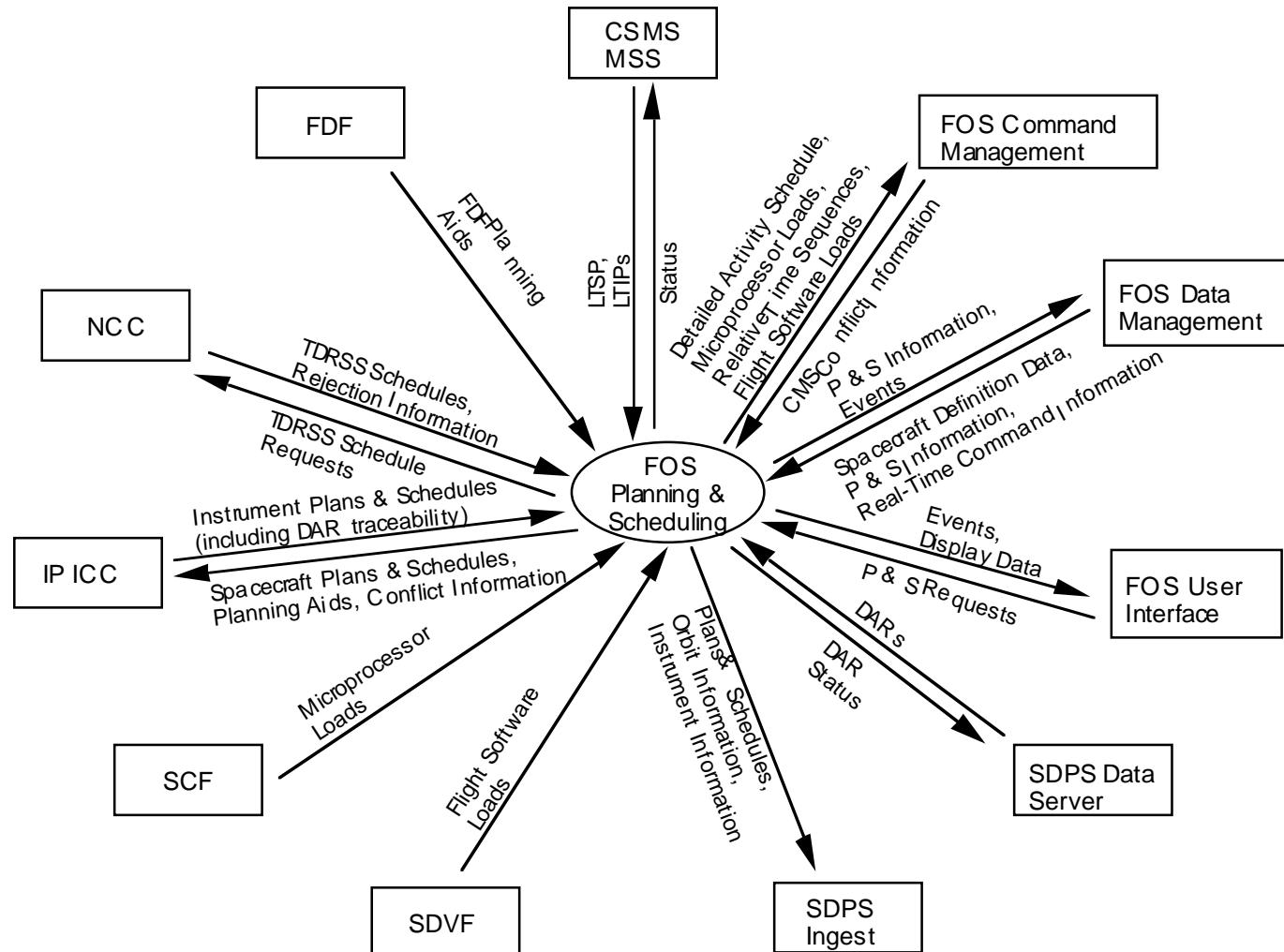
- Generate a conflict-free schedule for use in command load generation
 - Improve feedback during schedule development process

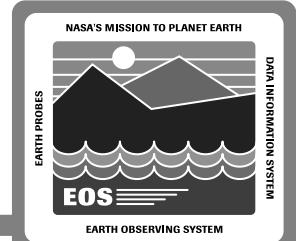
Minimize Life Cycle Costs

- Development and maintenance
 - Evaluation of mission planning heritage code (e.g. UPS, FORMATS)
 - Utilization of Hughes DELPHI product code
 - tested code minimizes development and test cycles
 - framework encompasses mission management experience
- Operations
 - Distributed architecture and automated functions reduce personnel required



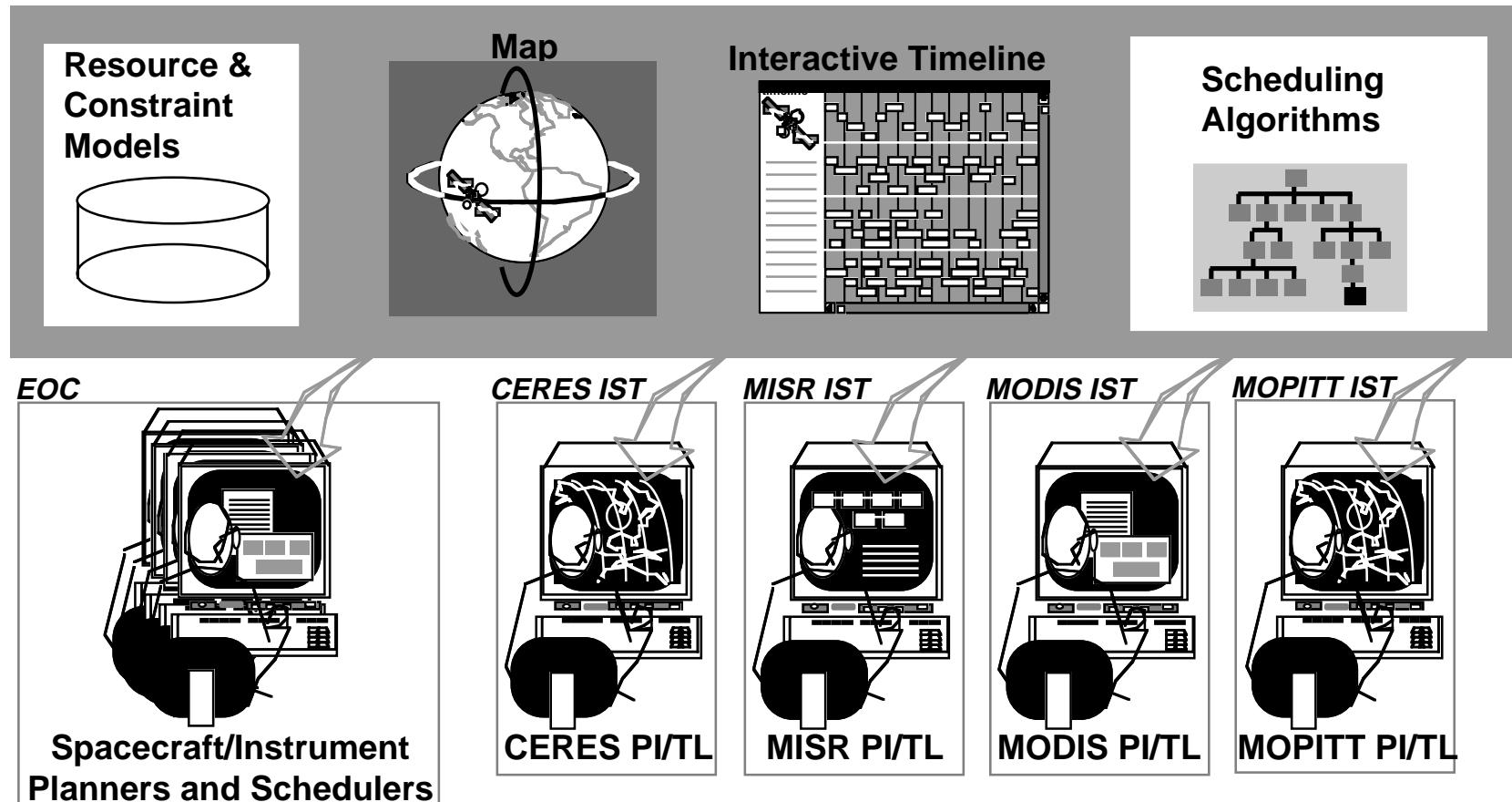
Context Diagram



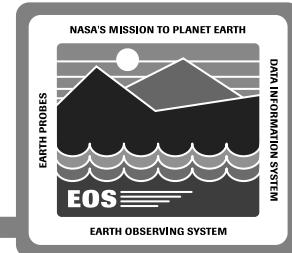


Context Diagram Overview

Common set of P & S capabilities provided to internal FOS elements.
For AM-1:



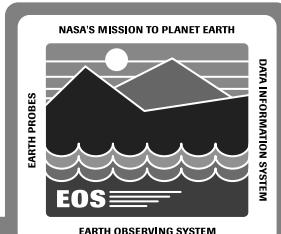
Context Diagram Overview (cont.)



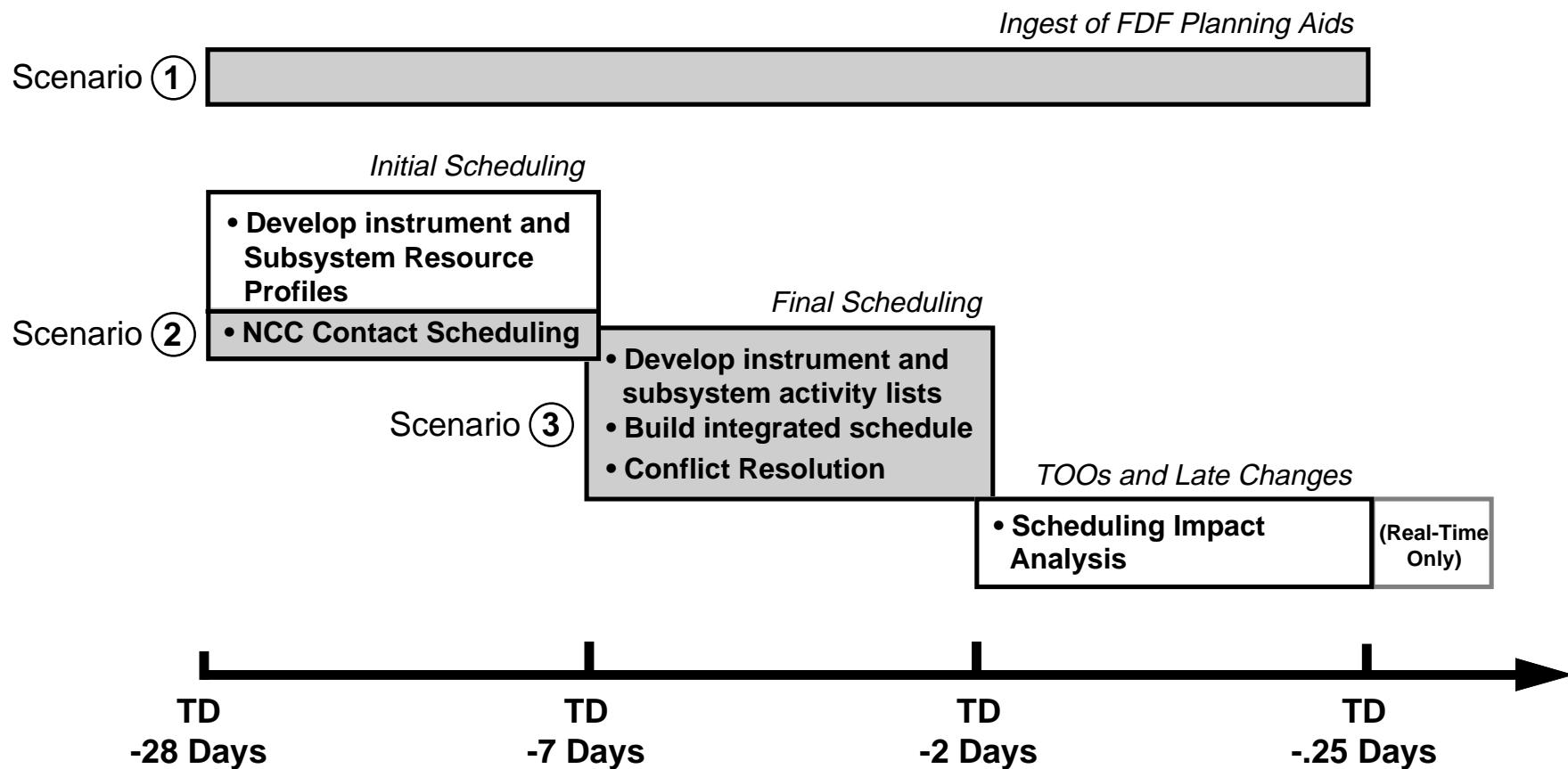
Data Flow Scenarios to demonstrate interaction between crucial interface elements

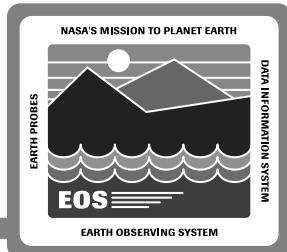
- Flight Dynamics Facility Data Ingest Scenario
(FDF, IP ICC, SDPS Ingest, FOS Data Management Subsystem)
- Establishment Of TDRSS Contact Times Scenario
(NCC, IP ICC)
- Final Scheduling Scenario
(IP ICC, FOS Command Management Subsystem, FOS Data Management Subsystem, SDPS Ingest)

Context Diagram Overview (cont.)



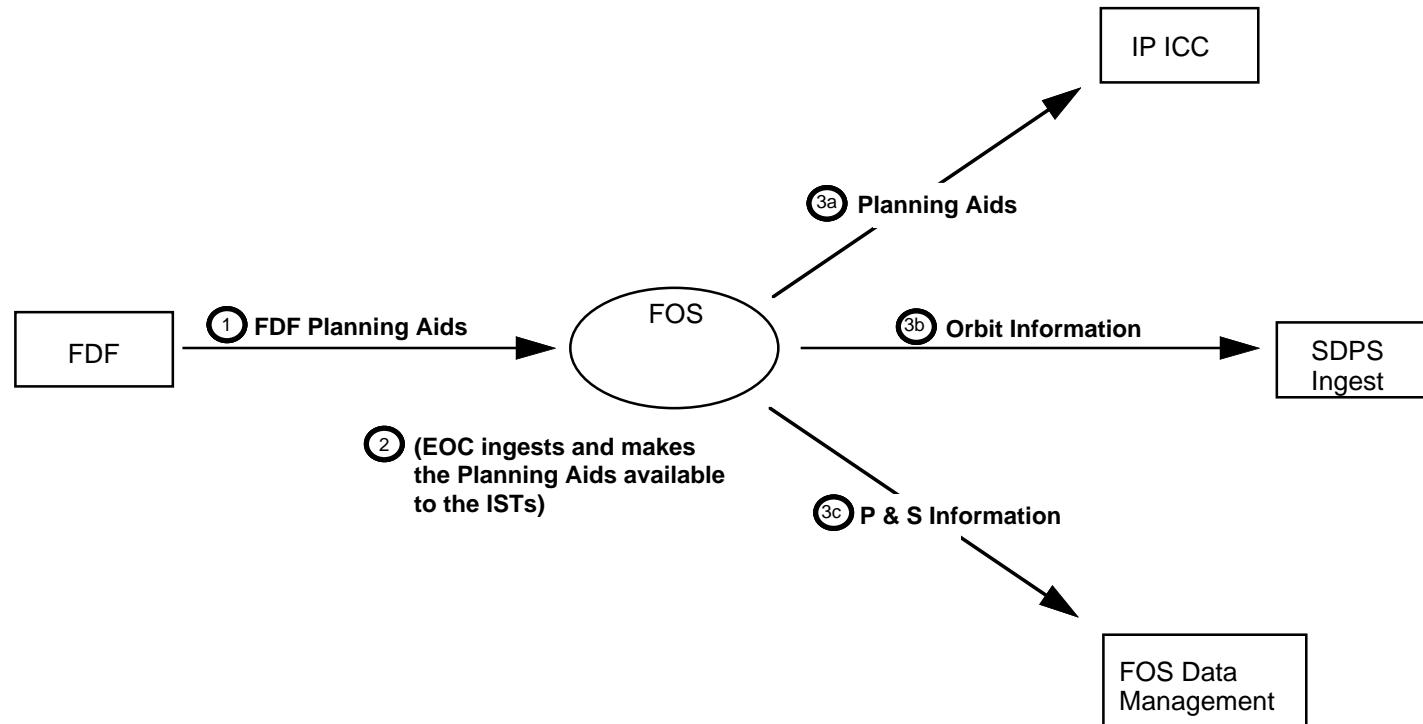
Scenario Timeline Functions



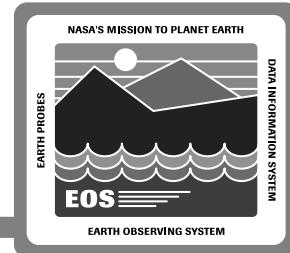


Context Diagram Scenarios

Flight Dynamics Facility (FDF) Data Ingest Scenario



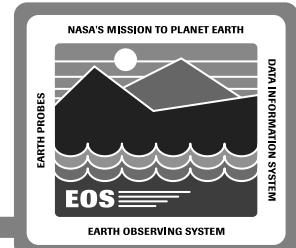
Context Diagram Scenarios (cont.)



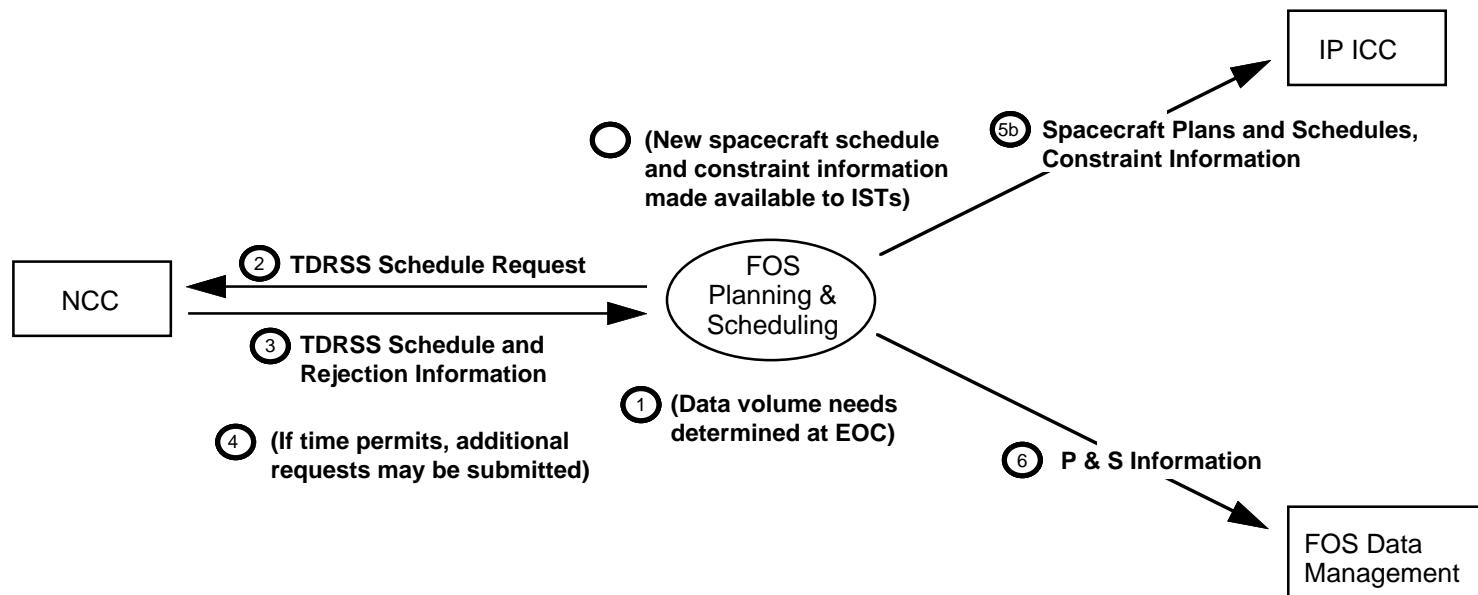
Flight Dynamics Facility (FDF) Data Ingest Scenario

- (1) The FDF submits Planning Aids to the EOC element of the FOS P & S subsystem, including:**
ephemeris, TDRSS availability times, orbital events and other related information
- (2) Upon receipt, EOC ingests the data and makes it available to the ISTs**
- (3) The EOC distributes the FDF orbit data to:**
 - (a) IP ICCs for instrument planning and scheduling**
 - (b) SDPS Ingest to assist in DAR generation**
 - (c) FOS Data Management Subsystem for data archive**

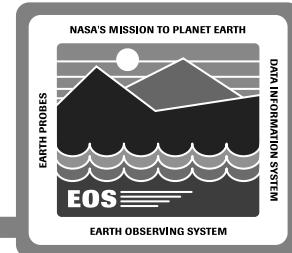
Context Diagram Scenarios (cont.)



Establishment Of TDRSS Contact Times Scenario



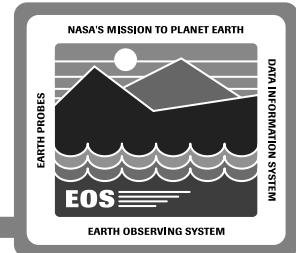
Context Diagram Scenarios (cont.)



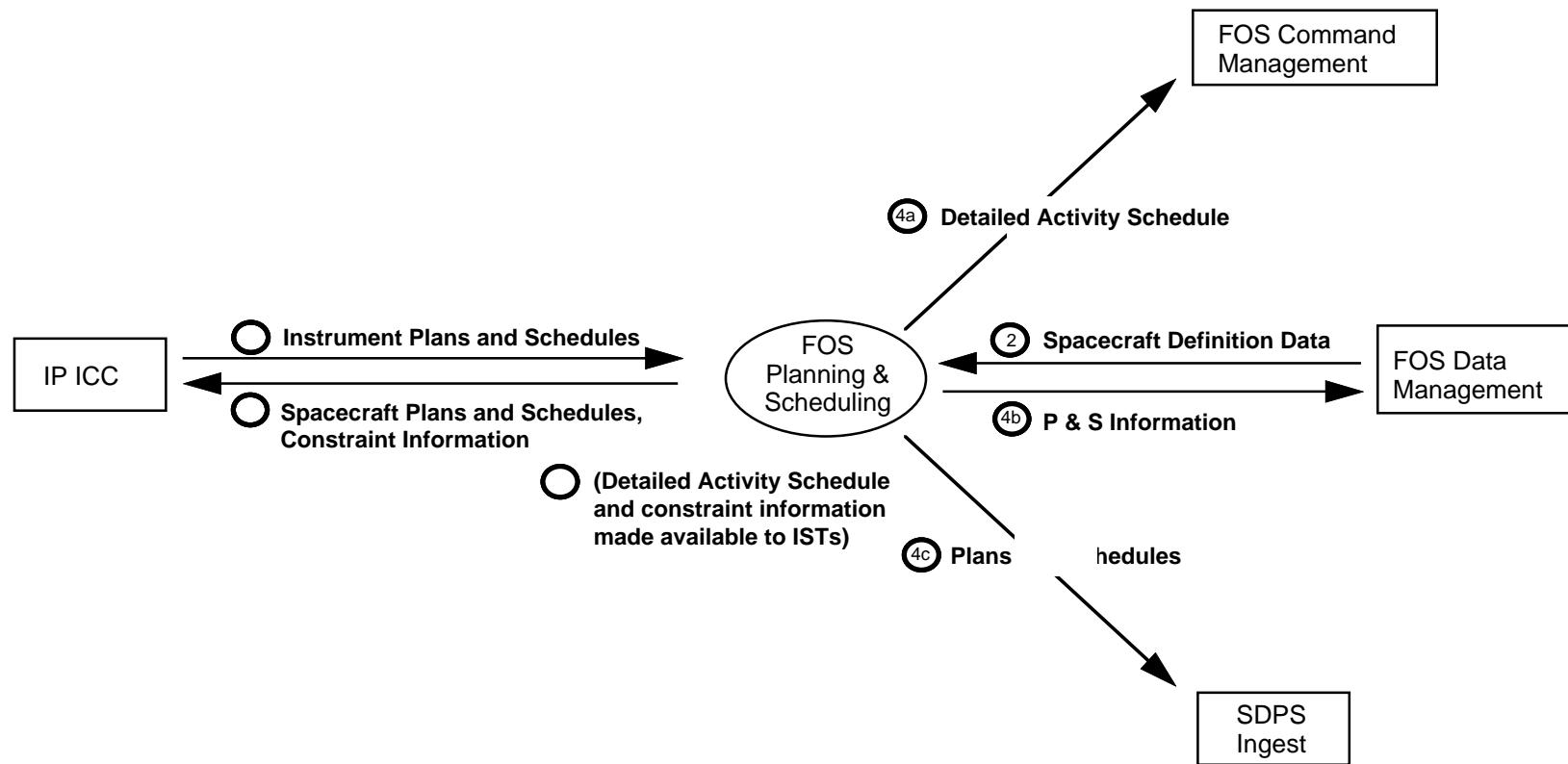
Establishment Of TDRSS Contact Times Scenario

- (1) Instrument and subsystem schedules are integrated together at the EOC to establish data volume needs**
- (2) The EOC generates a 7-day TDRSS contact request and submits it to the NCC**
- (3) NCC responds with TDRSS schedules, along with any rejection information**
- (4) If time permits, the EOC may continue negotiations with the NCC**
- (5) The new mission plan (i.e. Preliminary Resource Schedule) and constraint information is distributed by the EOC:
 - (a) internally to ISTs**
 - (b) externally to IP ICCs****
- (6) The new mission plan is archived at the FOS Data Management Subsystem**

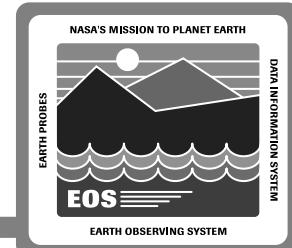
Context Diagram Scenarios (cont.)



Final Scheduling Scenario



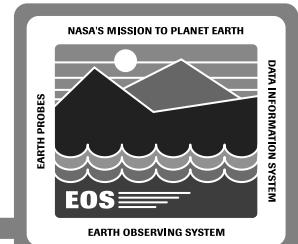
Context Diagram Scenarios (cont.)



Final Scheduling Scenario

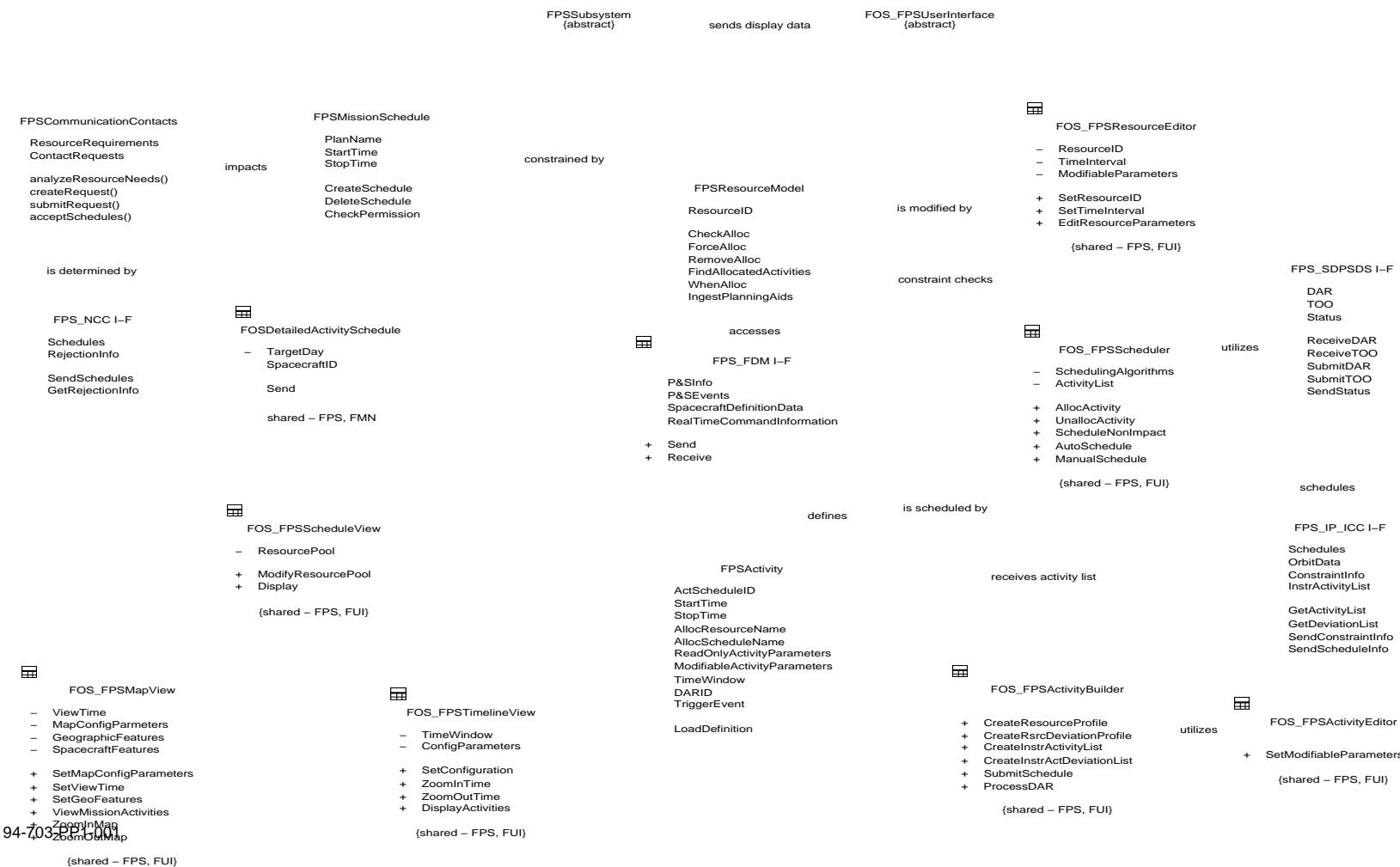
- (1) The IP ICC submits an instrument schedule to the EOC for schedule integration**
- (2) The EOC performs the final check of constraints based upon parameters defined in the Spacecraft Definition Data (e.g. power limits, jitter)**
- (3) The EOC builds a Detailed Activity Schedule and distributes it with any constraint information to:**
 - (a) internal ISTs**
 - (b) external IP ICCs**
- (4) The Detailed Activity Schedule is also distributed to:**
 - (a) FOS Command Management Subsystem to generate the command load and ground script**
 - (b) FOS Data Management Subsystem for data archive**
 - (c) SDPS Ingest for schedule visibility**

Planning & Scheduling Subsystem Design



Object Model - Part A: Primary User Scheduling Capabilities

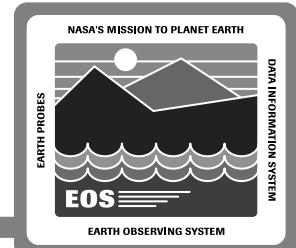
OMTObjectDiagram – PS_final_A 6/1/1994 14:58:12

194-703-B01-MAP
ZoomOutMap

(shared – FPS, FUI)

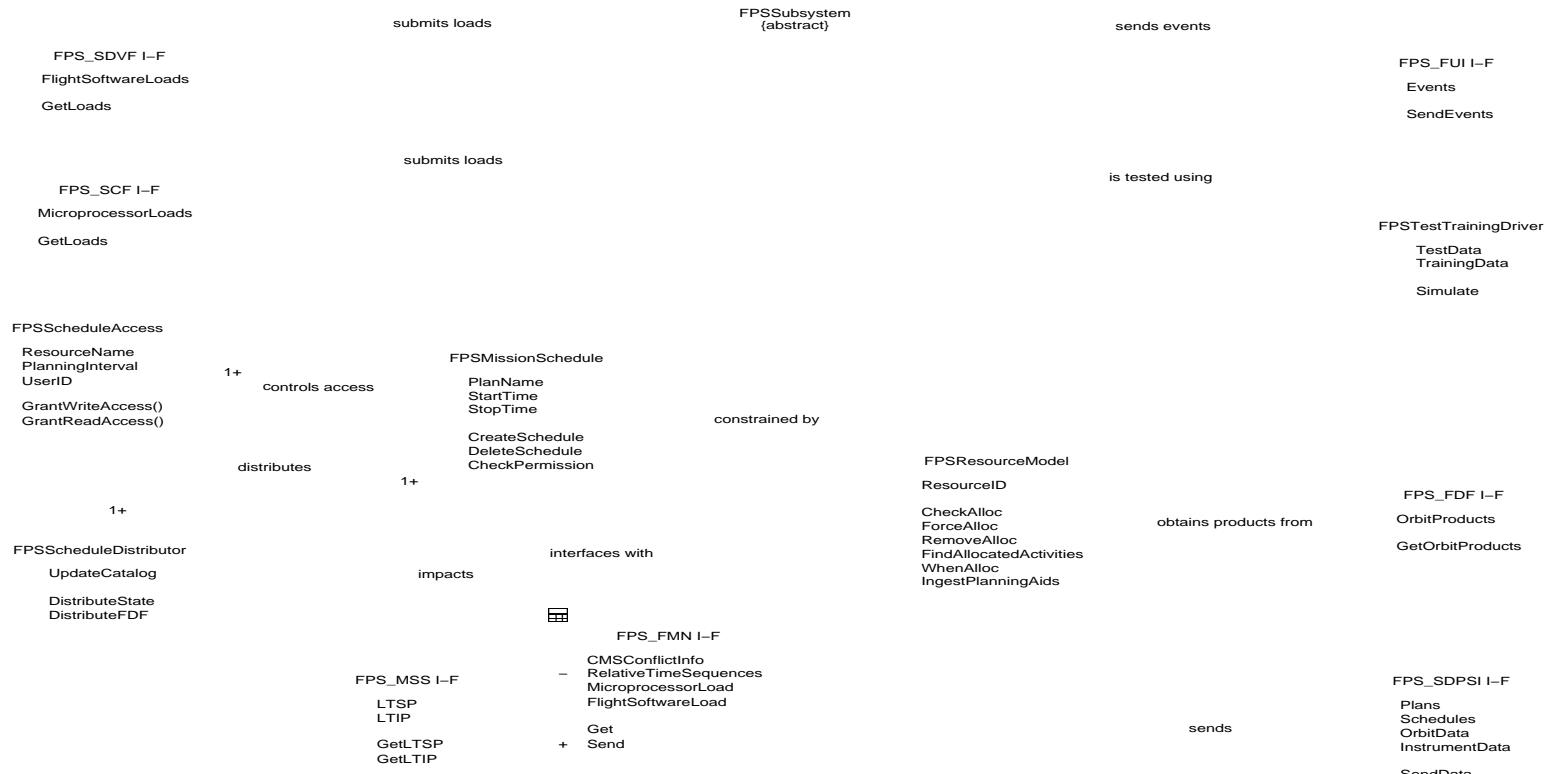
TC-18

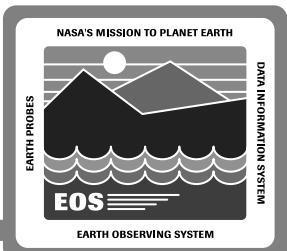
Planning & Scheduling Subsystem Design (cont.)



Object Model - Part B

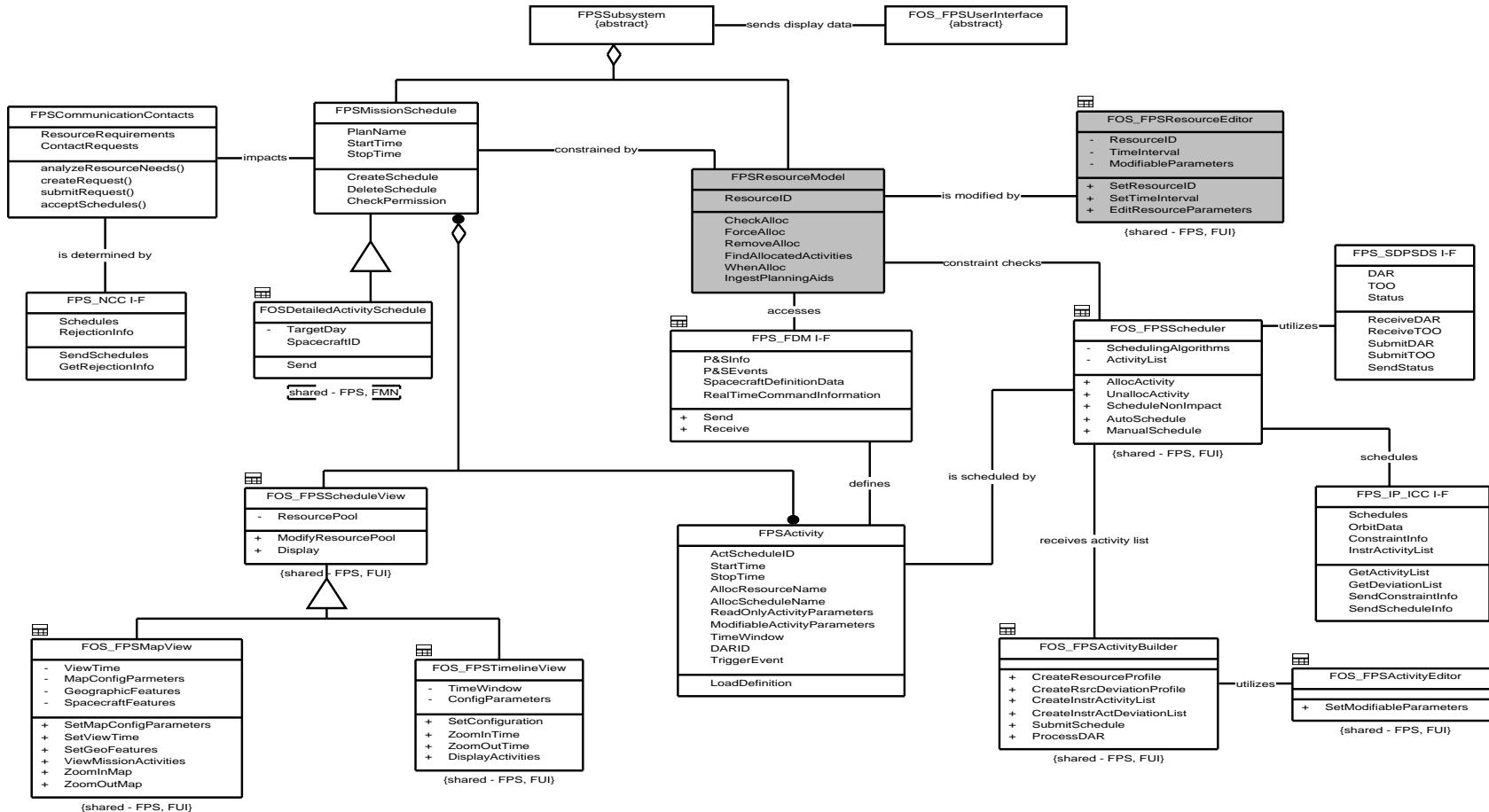
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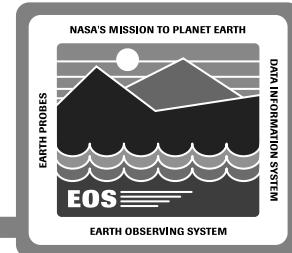


Object Model Overview

Physical Modeling Of Mission Elements



Object Model Overview (cont.)

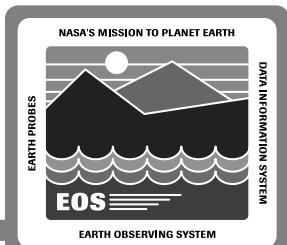


Physical Modeling Of Mission Elements

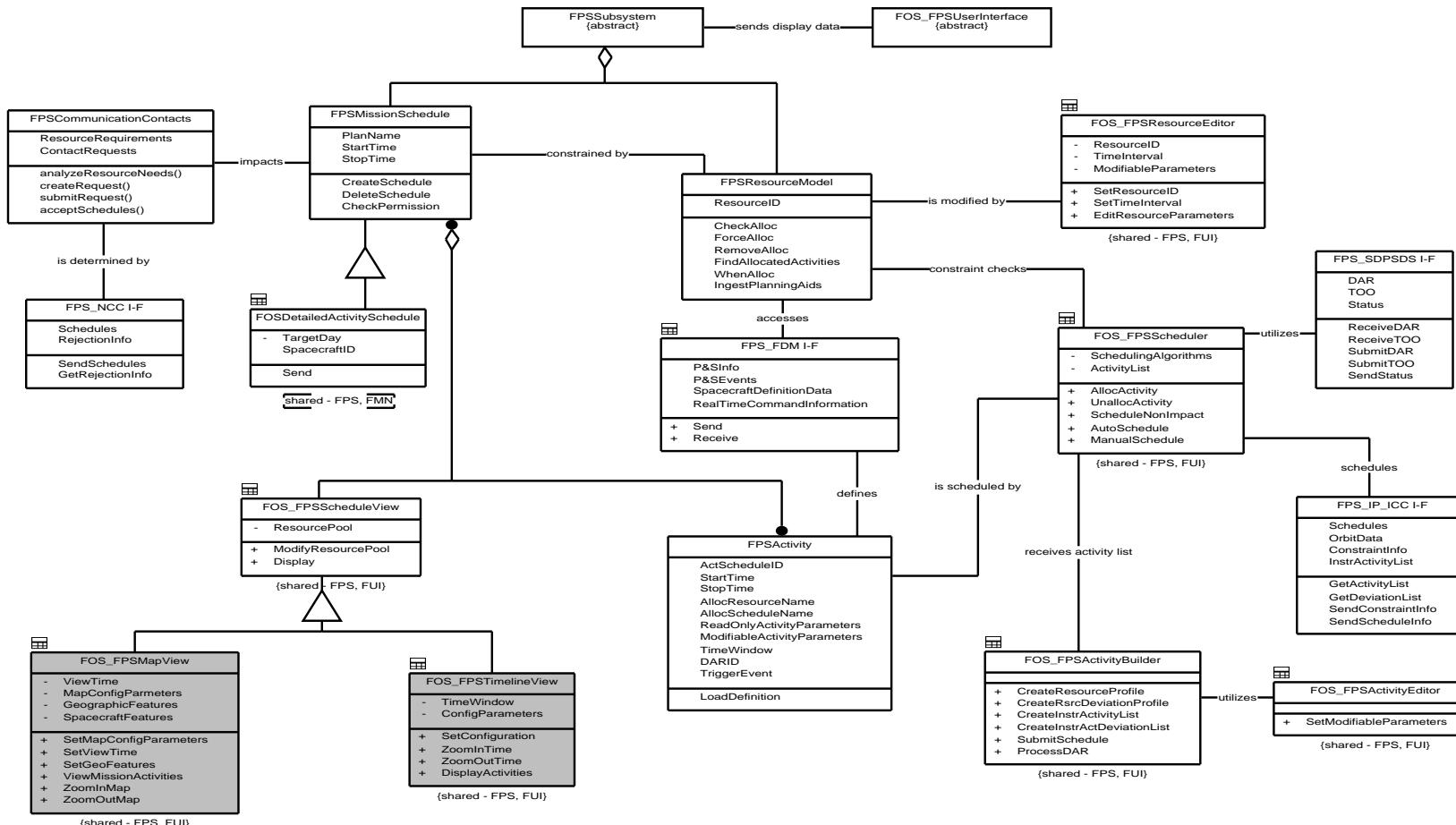
Class: FPSResourceModel and FOS_FPSResourceEditor

- **Performs physical modeling of instruments and spacecraft subsystems**
- **Isolates constraint checking of mission resources to accommodate changes and modifications to spacecraft constraints**
- **Provides hooks for future instruments and subsystems through generic resource behaviors**
- **Performs distributed planning and scheduling by providing independent constraint checking capability to PIs/TLs and Instrument/Spacecraft planners and schedulers**

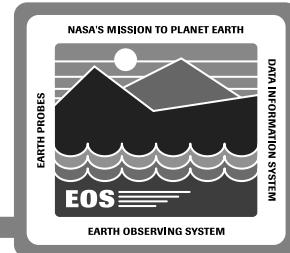
Object Model Overview (cont.)



Global Visibility into Mission Plan



Object Model Overview (cont.)

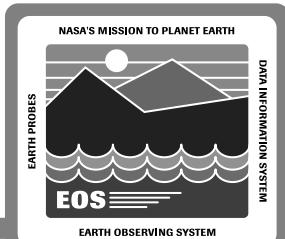


Global Visibility into Mission Plan

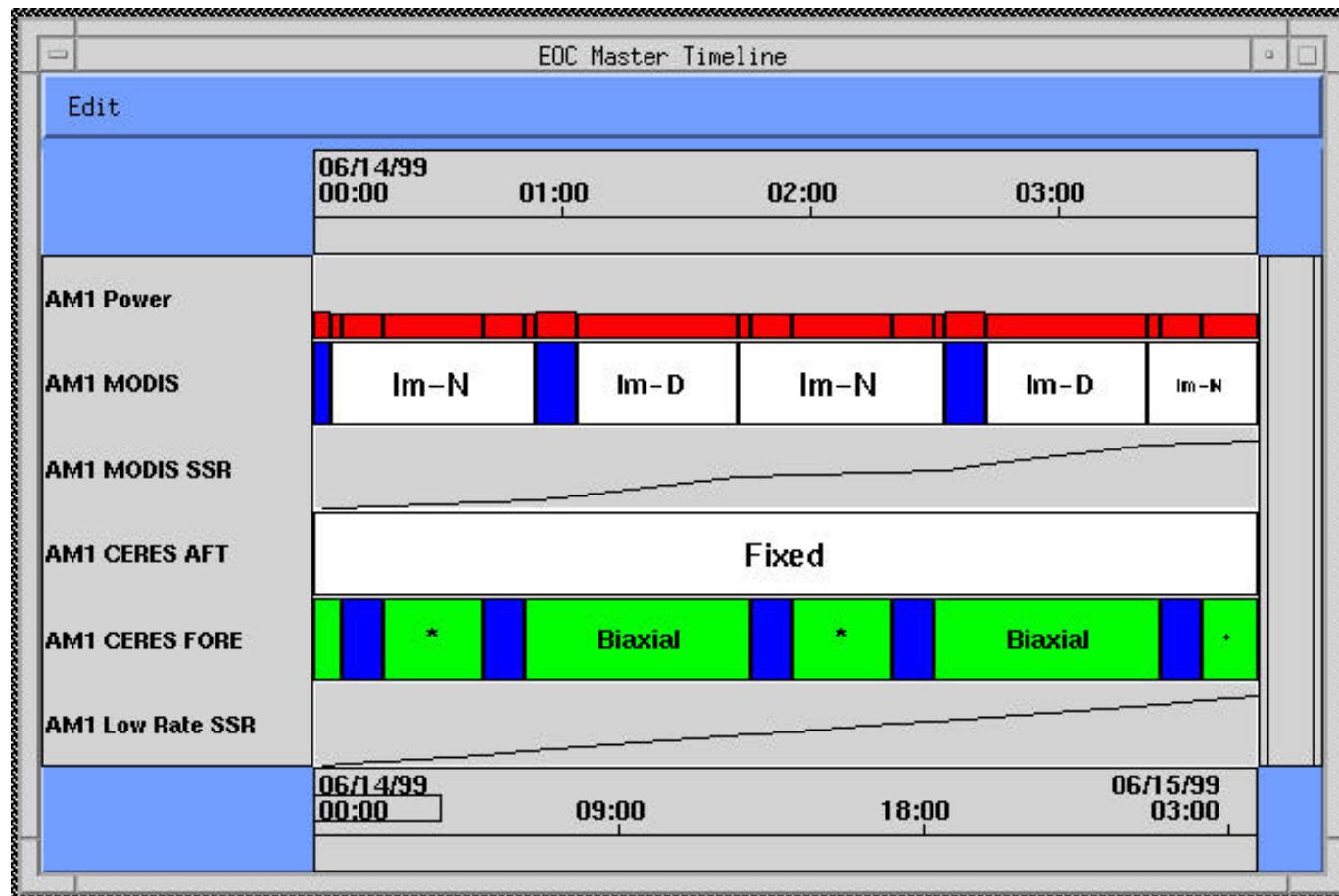
Classes: **FOS_FPSTimelineView** and **FOS_FPSMapView**

- Display schedules through time and space
- Provide global visibility into mission plan state
 - EOC and ISTs have visibility into all mission resources, including constraints
 - Views update based upon distributed, real-time schedule changes
- Provide analysis capabilities for PIs/TLs and Instrument/Spacecraft planners and schedulers
- User configuration of displays

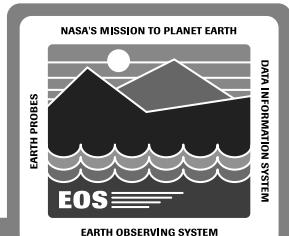
Object Model Overview (cont.)



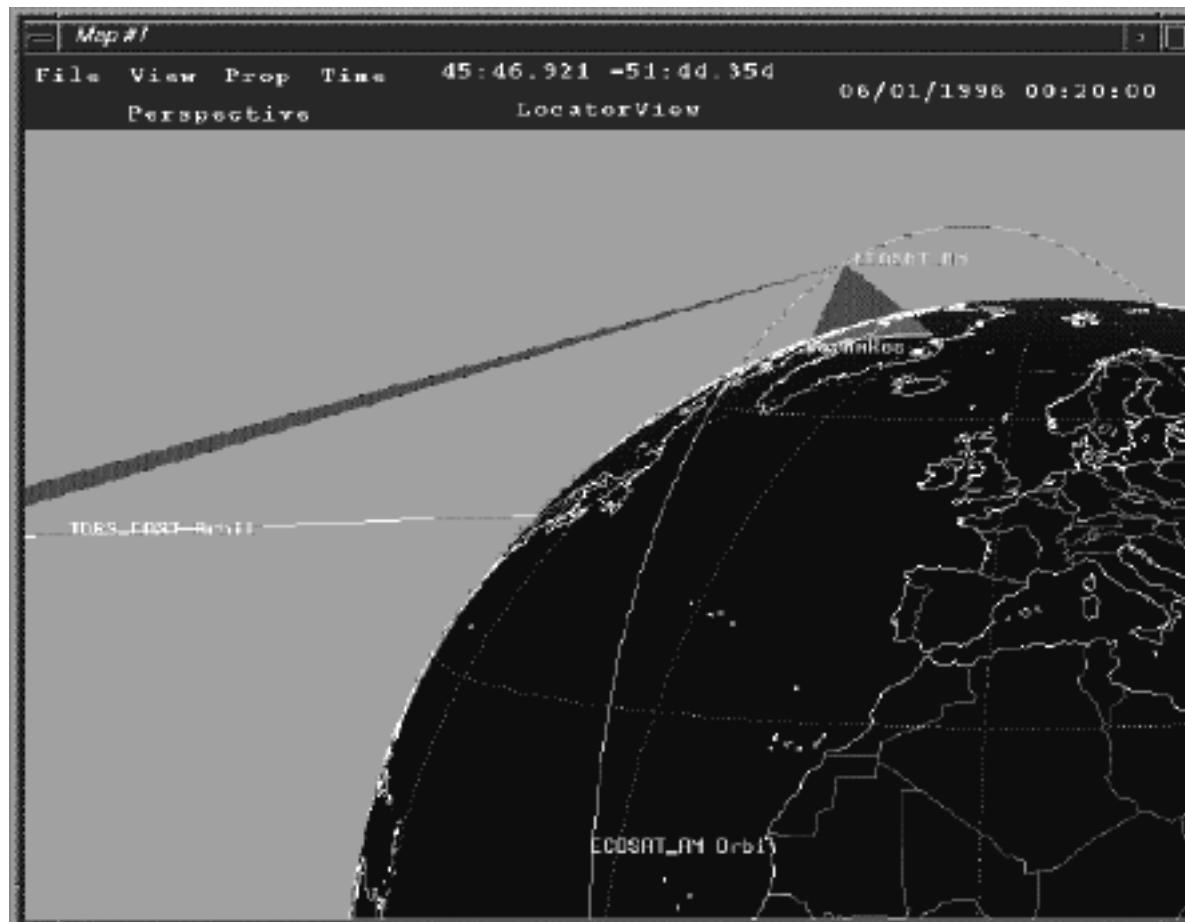
Example of Timeline Display:



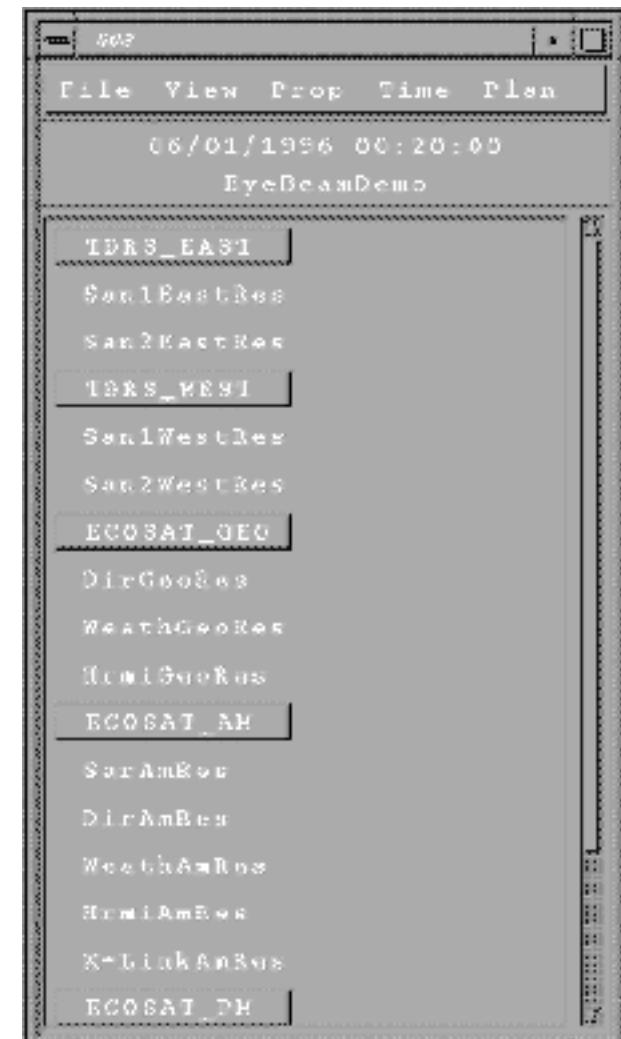
Object Model Overview (cont.)



Example of Map Display:

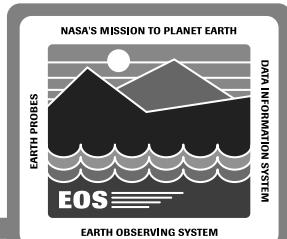


194-703-PP1-001

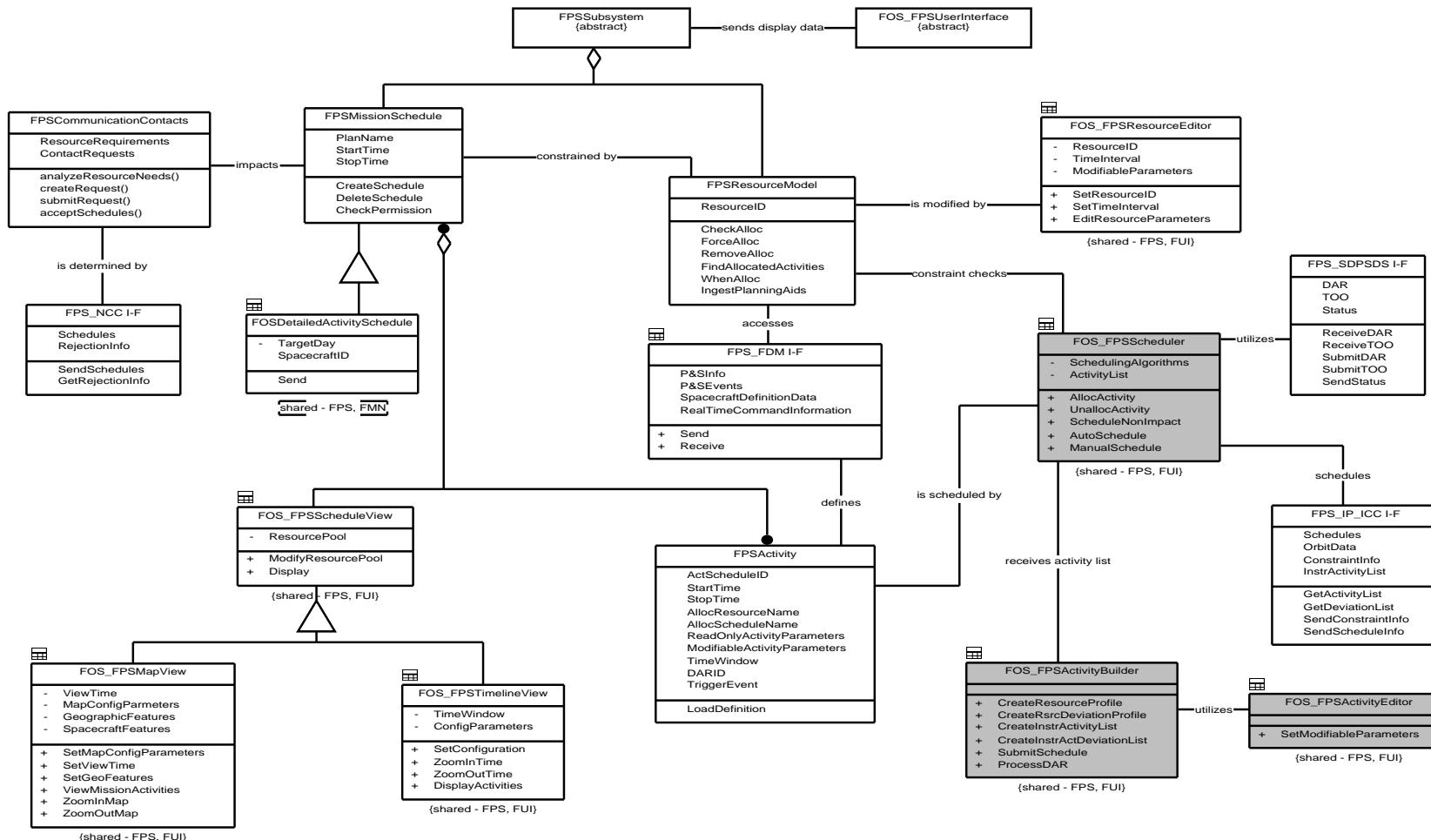


TC-25

Object Model Overview (cont.)



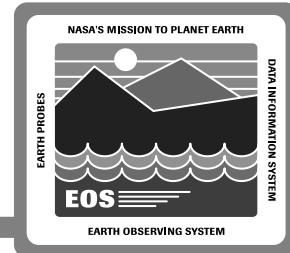
Interactive and Automatic Scheduling



194-703-PP1-001

TC-26

Object Model Overview (cont.)

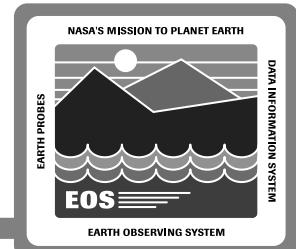


Interactive and Automatic Scheduling (based upon user authorization)

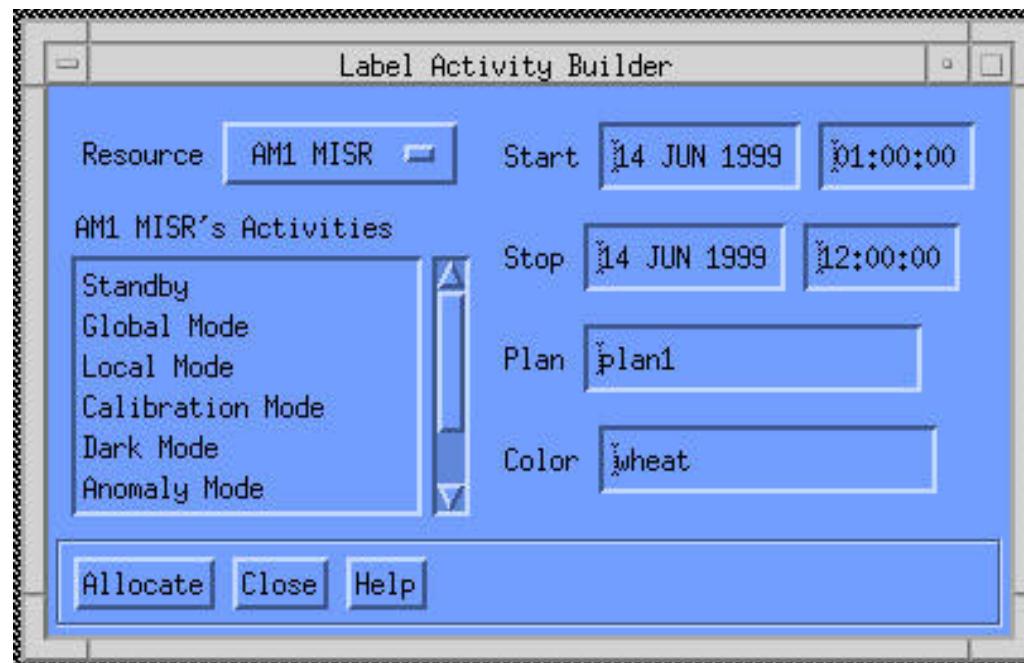
Classes: **FOS_FPSScheduler**, **FOS_FPSActivityBuilder**,
FOS_FPSActivityEditor

- Flexibility to incorporate evolving Baseline Activity Profile definitions
- Capability to modify Baseline Activity Profiles interactively
 - Modification of activity parameters (e.g. gain setting, start/stop time)
- Provide non-impact mode (“what-if”) for scheduling analysis and conflict resolution
- Provide hooks for user defined scheduling algorithms to address automatic scheduling needs of spacecraft and instrument planners and schedulers

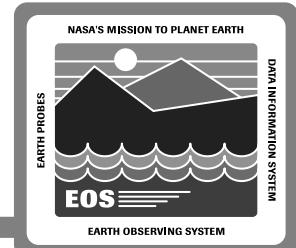
Object Model Overview (cont.)



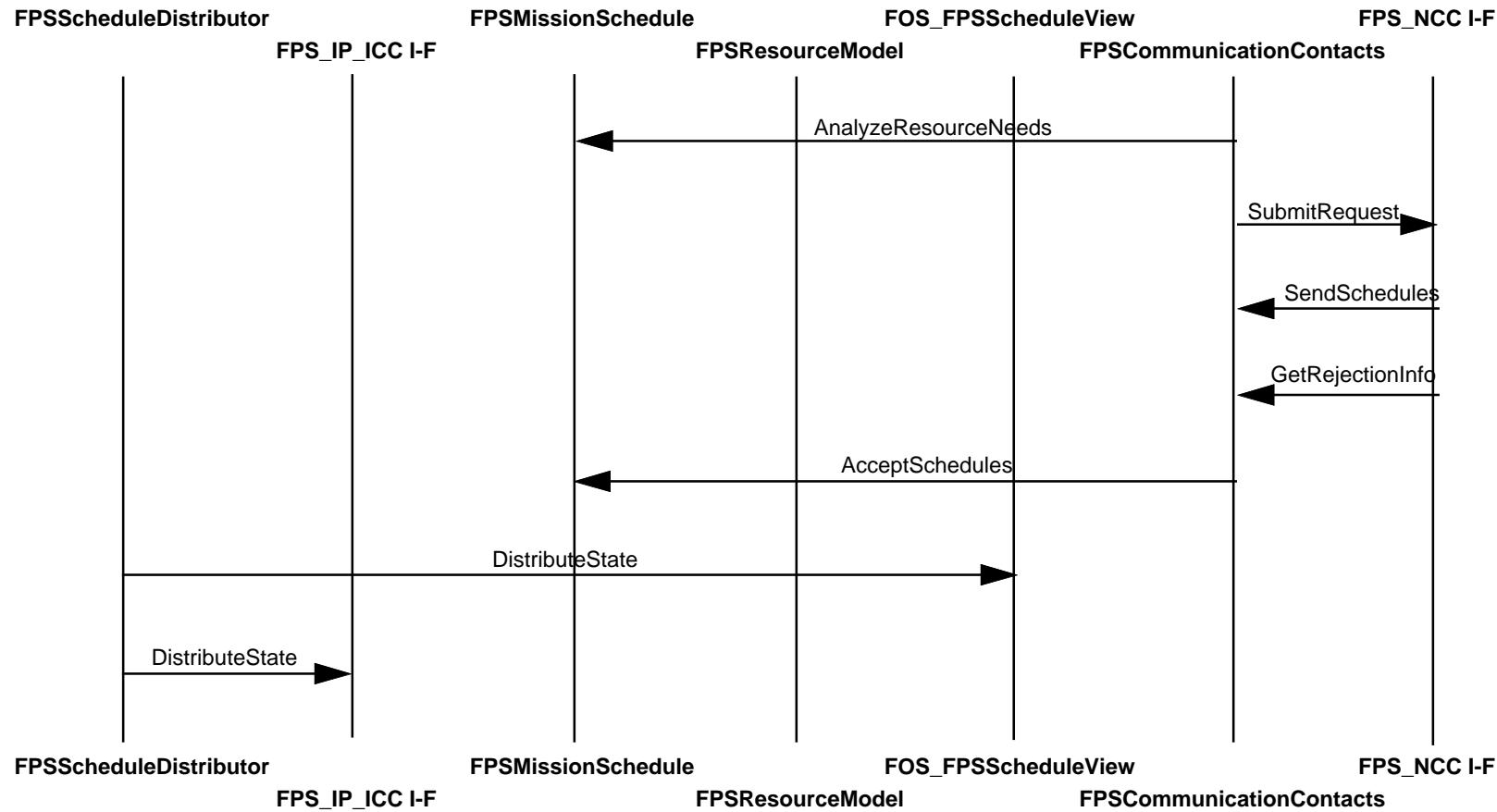
Example of Activity Builder:



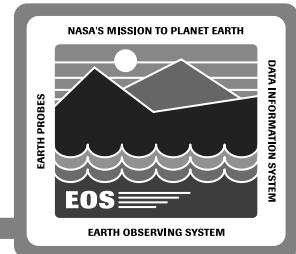
Planning & Scheduling Design Scenarios



Establishment of TDRSS Contact Times Scenario



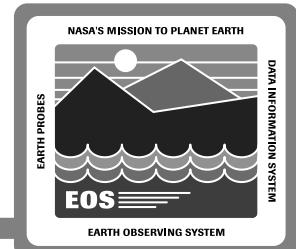
Planning & Scheduling Design Scenario (cont.)



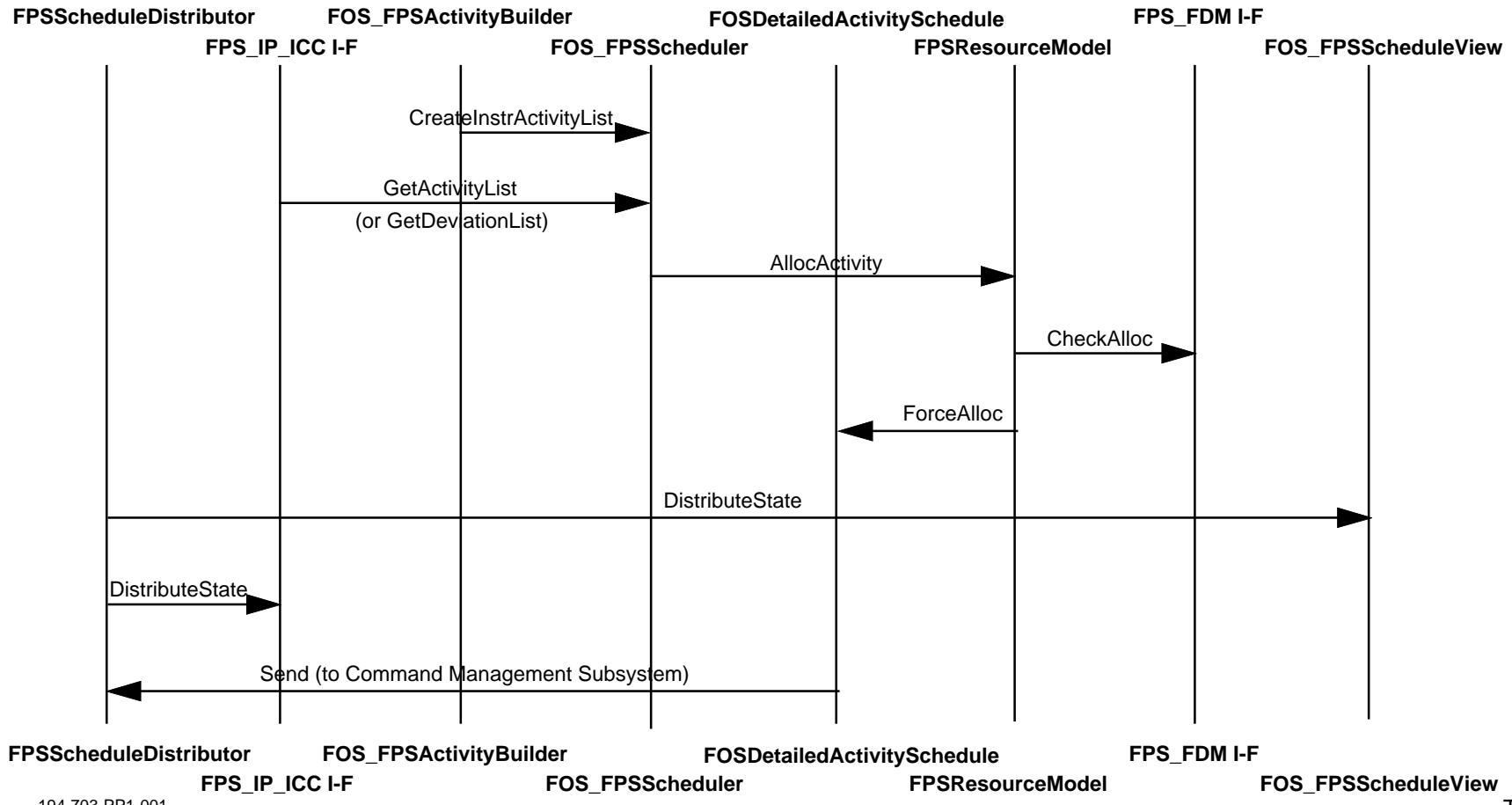
Establishment of TDRSS Contact Times Scenario

- Data volume needs analyzed at the EOC using `FPSCommunicationContacts` class
- Based on recorder playback requirements and TDRSS availability times, a TDRSS contact request is sent to the NCC via `FPS_NCC_I-F` class
- NCC TDRSS contact times integrated into the `FPSMissionSchedule` class, producing a Preliminary Resource Schedule for distribution
- PI/TL has global visibility into the EOC mission plan through `FOS_FPScheduleView` class (timeline and map view)
- Instrument planners and schedulers at IP ICCs receive the Preliminary Resource Schedule through the `FPS_IP_ICC_I-F` class

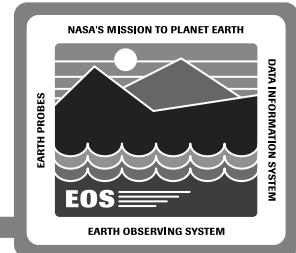
Planning & Scheduling Design Scenarios (cont.)



Final Scheduling Scenario



Planning & Scheduling Design Scenarios (cont.)



Final Scheduling Scenario

- Instrument Activity Deviation Lists for non-complex instruments are built by the Instrument planner and scheduler using the `FOS_FPSActivityBuilder` class, if needed
- Complex instruments submit Instrument Activity Lists or Instrument Activity Deviation Lists to the EOC via `FPS_IP_ICC` I-F class
- All activity lists are integrated at the EOC utilizing `FOS_FPSScheduler` class
- During scheduling, constraint checking is performed against `FPSResourceModel` class using constraint parameters received from the FOS Data Management Subsystem
- `FOSDetailedActivitySchedule` and constraint information submitted to ISTs and IP ICCs for global visibility into mission schedule
- `FOSDetailedActivitySchedule` released to CMS for command load and ground script generation

Summary

